

A close-up photograph of a kiwi fruit slice resting on the rim of a glass filled with a white, frothy yogurt drink. The kiwi slice is cut horizontally, showing its green flesh and dark brown seeds. The background is a soft-focus green, suggesting an outdoor setting.

Food 5450M Industrial Project: Food Innovation

*Yogurt based food: ‘Soy yogurt drink
with kiwi Flavour’*

Unit III: Defining product and process specifications

GROUP B

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Introduction



- **Aim** : develop and optimize the final product defining the product and process specifications by:
- developing the process and equipment flowchart according to legislation specifications
- conducting consumer sensory and descriptive analysis

Outline



- Process and equipment flowcharts for both laboratory and industrial scale
- Factory layout for the production process
- Design experiments for conducting product & process optimisation (Screening + Optimisation)
- Conduct sensory consumer & descriptive analysis
- Specify product & process formulations and determine whether are in compliance with relevant legislation



Laboratory Process Flowchart



Laboratory Process Flowchart

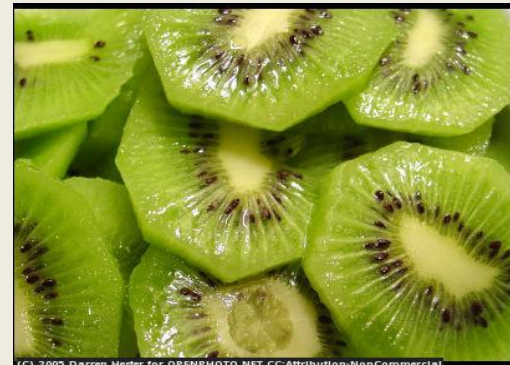


2 main processes

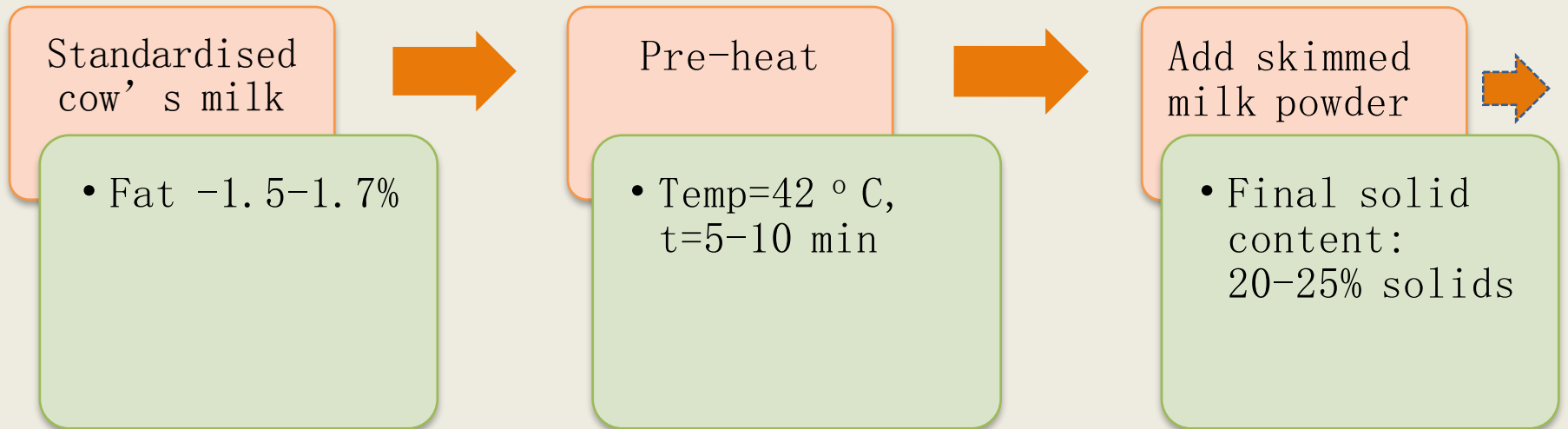


Yogurt
fermentation

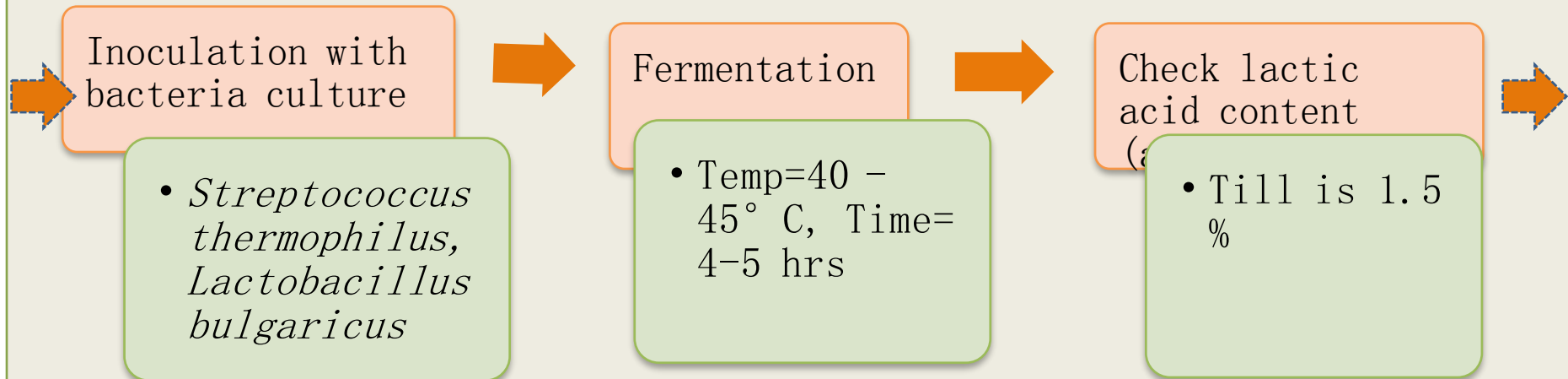
Kiwi juice
extraction



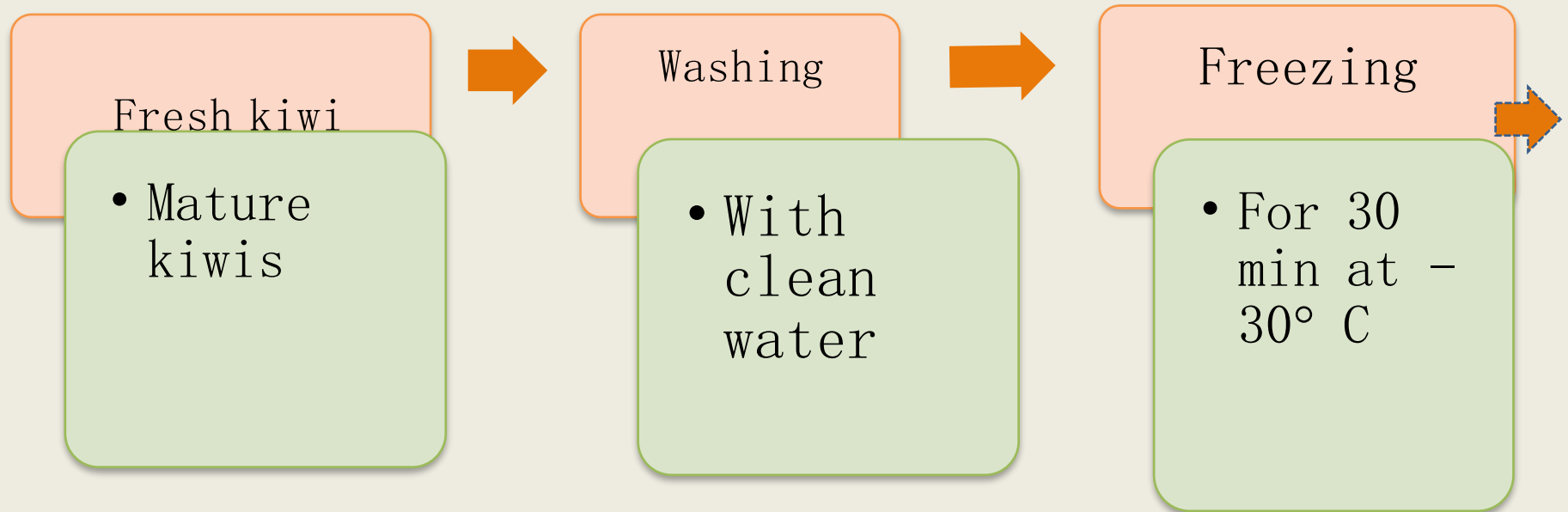
Laboratory Process Flowchart - *Yogurt Fermentation*



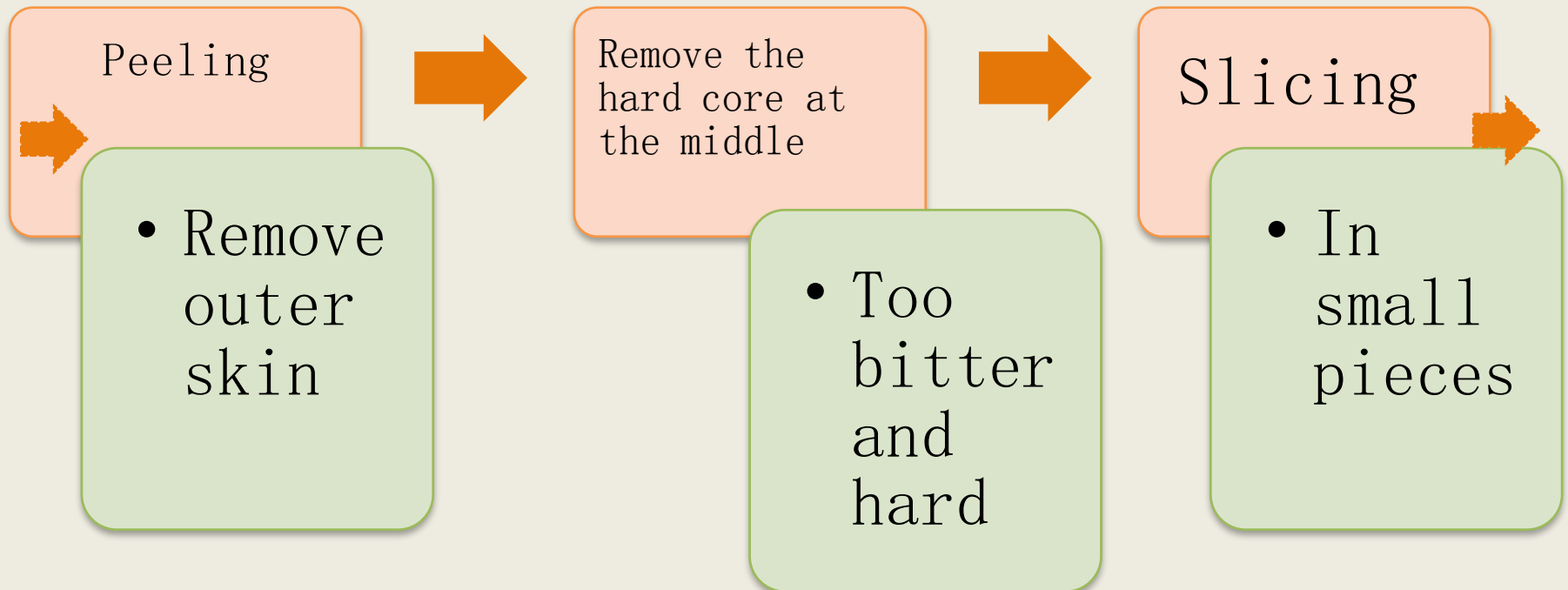
Laboratory Process Flowchart - *Yogurt Fermentation*



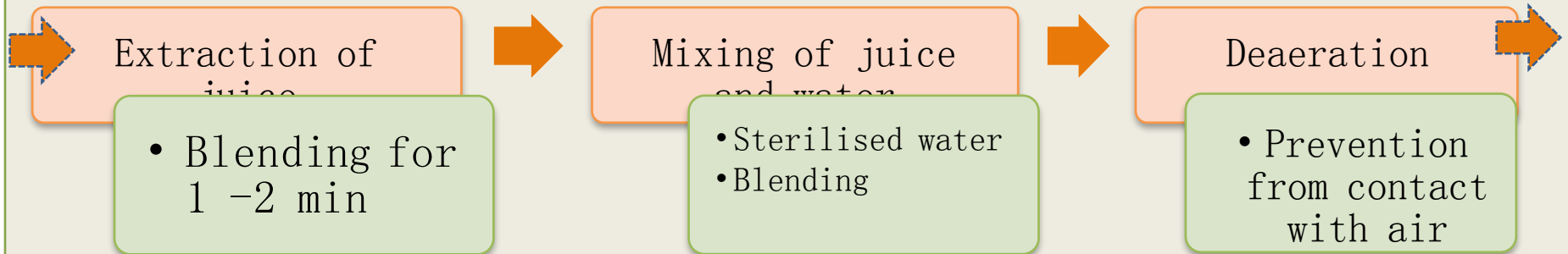
Laboratory Process Flowchart - *Kiwi* juice extraction



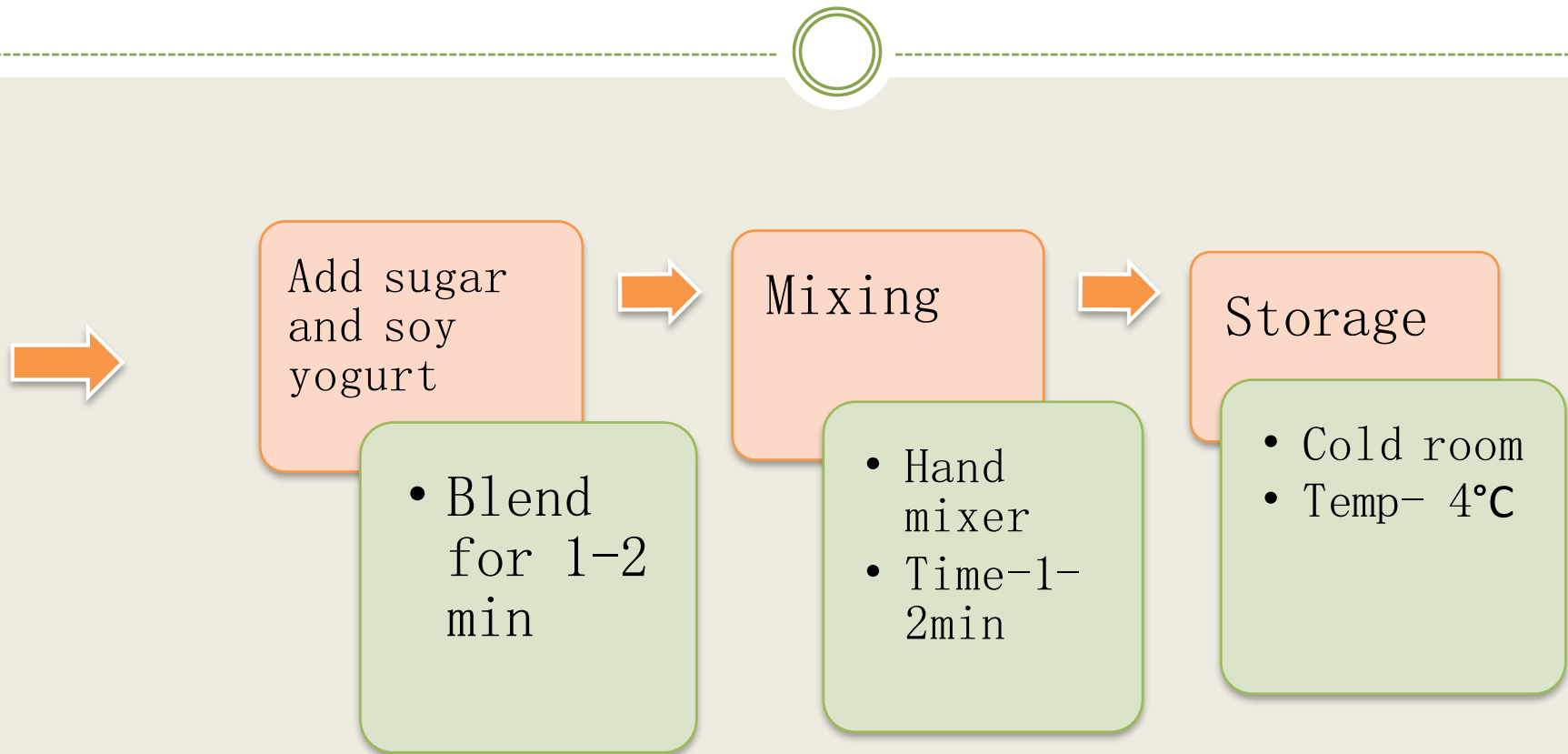
Laboratory Process Flowchart - *Kiwi juice extraction*



Laboratory Process Flowchart - *Kiwi* juice extraction



Laboratory Process Flowchart





Industrial Flow Chart





Industrial processing carries three lines



Cows yogurt

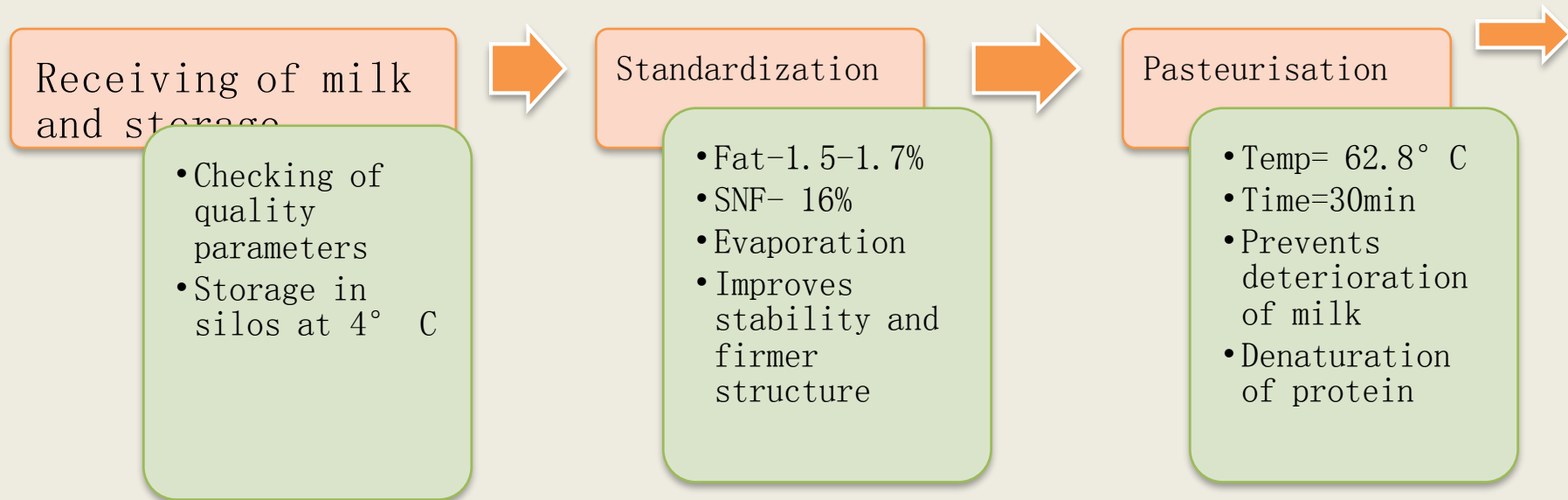


Soy
yogurt



Kiwi
juice

Cows yogurt and Soy yogurt (Line 1 and 2)



Cows yogurt and Soy yogurt (Line 1 and 2)

Homogenisation

- Reducing size of fat globules
- Temp=40–65°C

Inoculation and Fermentation

- (1–2%) *Streptococcus thermophilus* and *Lactobacillus bulgaricus*
- Temp=40–45°C
- Time= 4–5 hour
- convert sugar into lactic acid
- pH of final yogurt=4.2–4.5
- Preparation of stirred yogurt

Kiwi juice (Line 3)



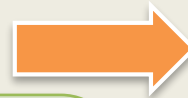
Receiving
kiwis

- Same variety and maturity



Sorting

- Size, appearance
- Remove rotten, unripened or extremely ripened



Washing

- In running water with 0.1% KMNO4



Kiwi juice (Line 3)



Drying

- Cold air line
- To prevent deterioration due to moisture

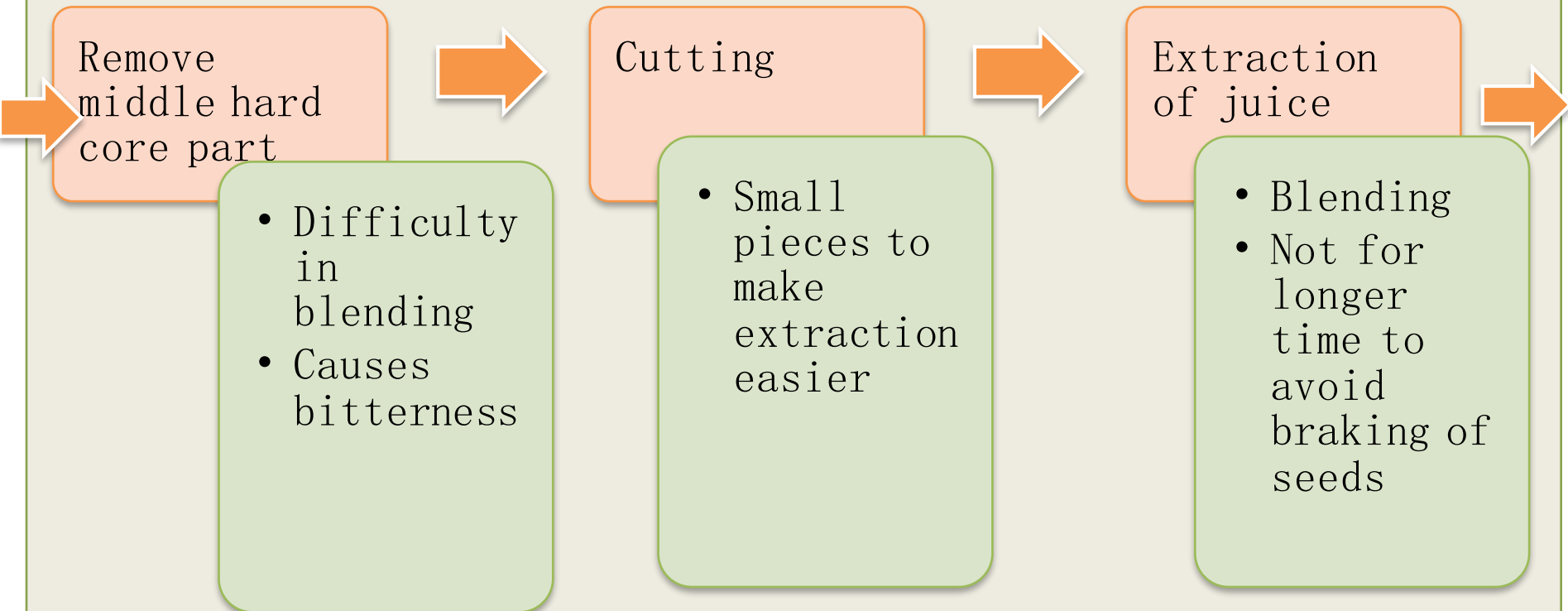
Chilling

- In cold room at -18°C for 30min

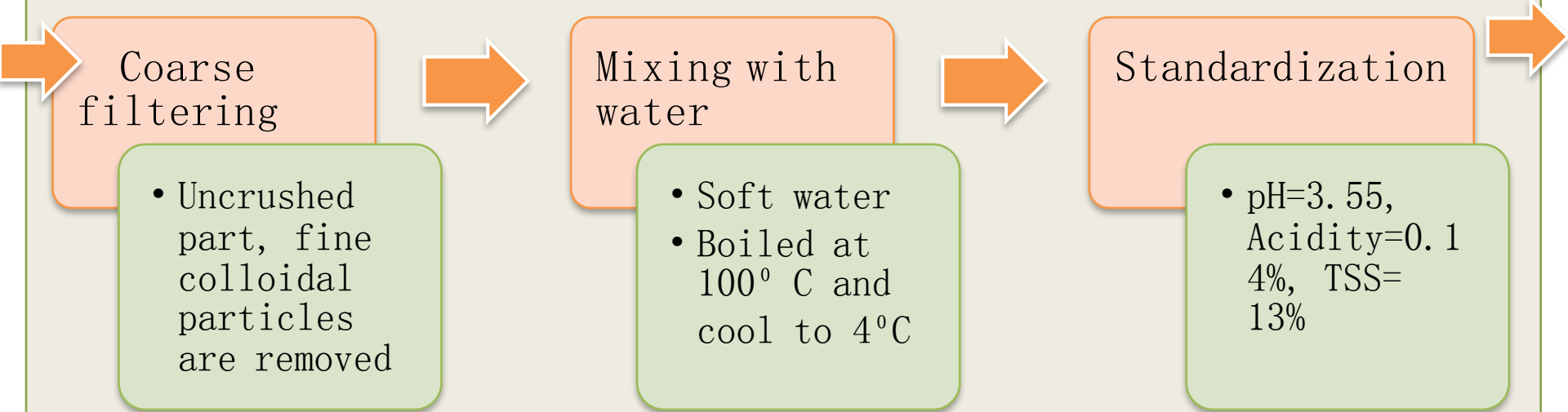
Peeling

- Outer skin of kiwi is removed

Kiwi juice (Line 3)



Kiwi juice (Line 3)



Kiwi juice (Line 3)



Deaeration

- Avoid contact of juice with air to prevent oxidation

Mixing

- Blending of soy yogurt, cows yogurt, sugar, kiwi juice together
- Stabiliser (0.01%) and citric acid (0.8%)

Checking of parameter

- MSNF=8–9.5%, Fat= 1.3–1.5%, pH= 4–4.5

Kiwi juice (Line 3)



Homogenisation

- Disruption of particles at pressure of 6MPa

Removing air from bottles and filling

- Remove Dust, dirt, air
- High speed filling
- Aseptic filling

Sealing and sterilization of bottles

- $T = 40^{\circ}\text{C}$
- $t = 2-3\text{min}$



Equipment

Equipments Selection Principle



- Capacity 5000----10000 units 2500l/day
- Time
- Standards
- Processing requirements
- CIP
- GMP
- HACCP
- Cost



Equipment



➤ TANKS

STORAGE TANK

FERMENTATION TANK

MULTIPURPOSE TANK; FERMENTATION

ONLY TANK; FERMENTATION/COOLING TANK
2500LITER

➤ SEPARATOR

THE TS-500-0 SEPARATOR

THE FINAL FAT CONTENT OF THE
PROCESS MILK IS WITHIN PRESET LIMITS (FROM
0% TO 3.5%)





Equipment



- Bath pasteurizer

500–1,000 L/Batch, 65° C

- Homogenizer

The TH-025 homogenizer, 500L per hour 0–65° C

- Cooling system

The cooling system (TC-6000) temperature ranges from 2–4° C

- Filling machine

The Dogaseptic series

- Blender

Gasti DOGAmix 60





Equipment



➤ Deaerator

FrymaKoruma Vacuum Deaerating Unit type VE

➤ Labelling machine

➤ Heat exchanger

- plate heat exchanger (PHE)
- tubular heat exchanger, including the multitube or multichannel designs
- scraped/swept surface heat exchanger.

➤ CIP system



Regulation



- Drinking yogurt-----yogurt products
- Flavoured fermented milk-----not contain more than 15% of fruit
- milk protein in fermented milk and yogurt $>2.7\%$,
- Milk fat in fermented milk $<10\%$ and $<15\%$ in yogurt
- Acidity (expressed as the percentage of lactic acid) of fermented milk $>0.3\%$ and 0.6% in yogurt.
- Sum of the microorganisms constituting started culture $> 10^7$ in both fermented milk and yogurt

Regulation



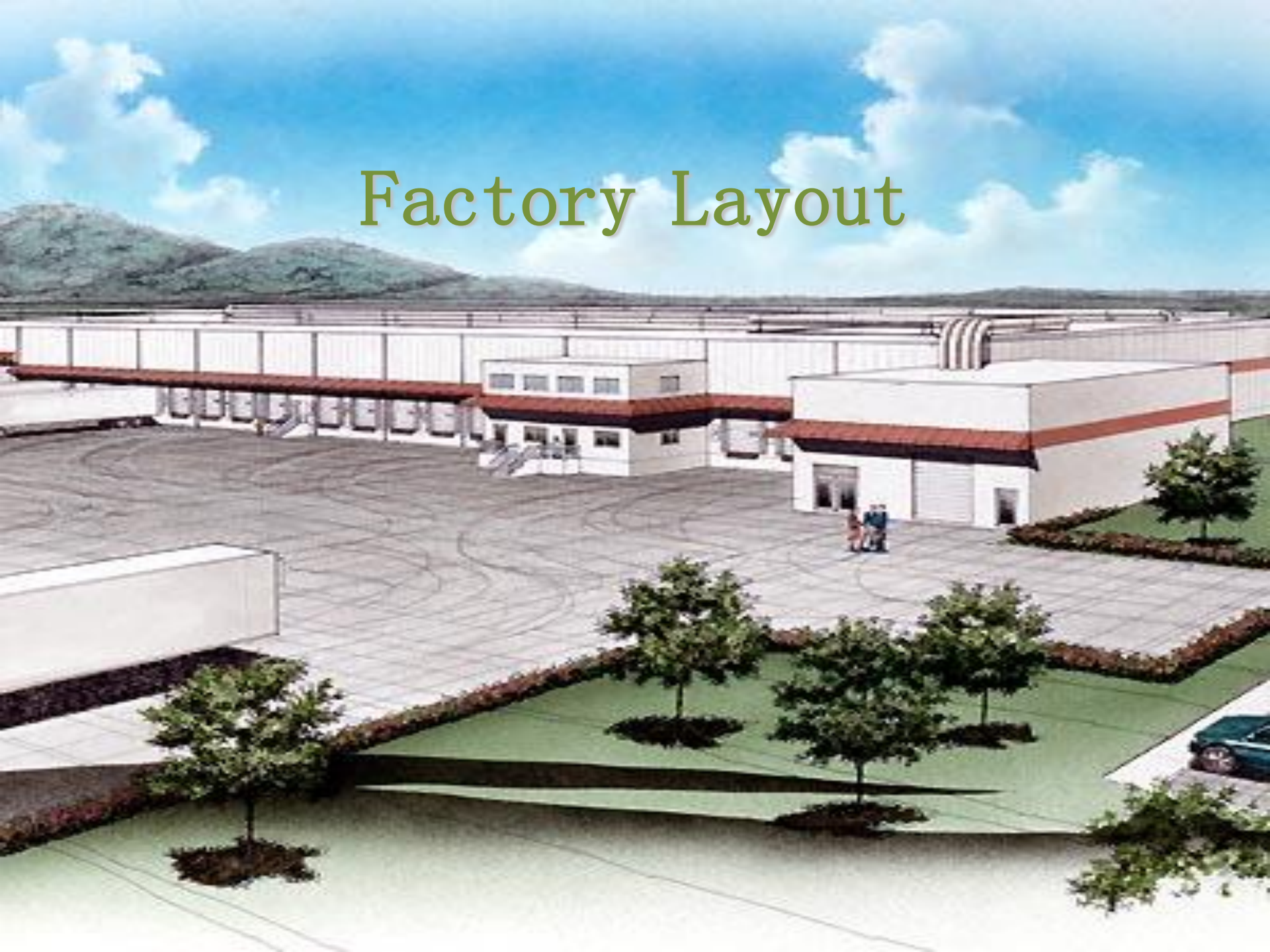
➤ Pasteurization

Temperature > 71.7° C for 15 seconds or
> 62.8° C for 30 minutes then cooled to 10° C

➤ Labelling

list of ingredients. Food Labelling regulation (1996)
Allergies Information : milk , soy

Factory Layout



Factory Layout Design



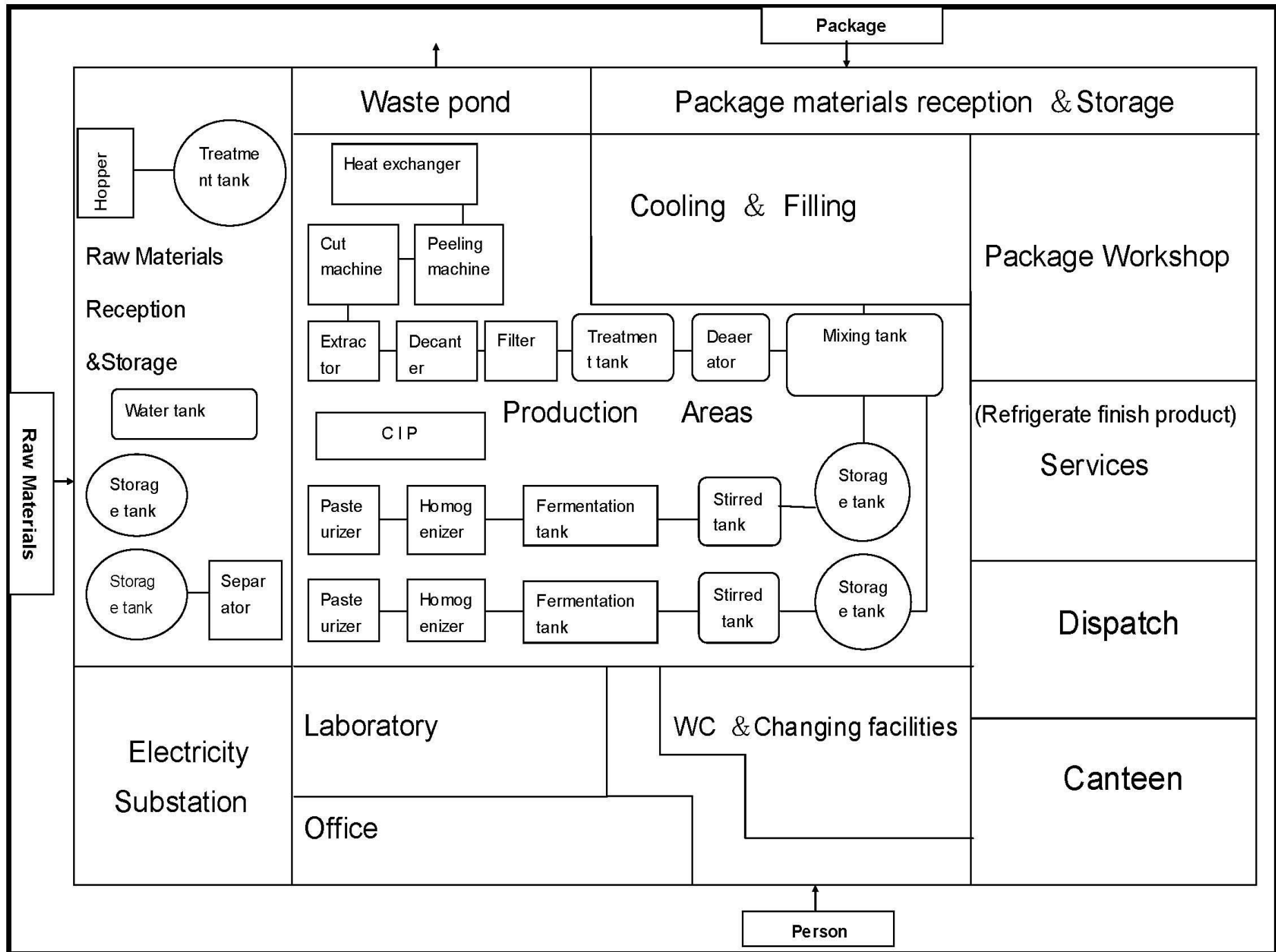
Ensure appropriate layout to:

- Comply with Accreditation Standard requirements
- Legislative requirements
- Efficient utilisation of resources

Plan of layout



- Raw material warehouse
- Production area
- Packaging workshop
- Refrigeration plant
- Laboratory
- Locker room and toilet
- Electricity substation room and machine repair shop
- Reserving area



Important point for layout design



- All functions should be processed with no criss-crossing and backtracking
- Visitors should move from clean to unclean areas
- Ingredients should move from dirty to clean areas as they become incorporated into food products
- Conditioned air and drainage should flow from clean to dirty areas
- The flow of discarded outer packing material should not cross the flow of products
- There is sufficient space for plant operations including processing, cleaning and maintenance. Space is also required for movement of materials and pedestrians



Experiment design and screening results

Product acceptability and preference experiment design

- Preference test using 9-point hedonic scale
- Number of assessors was determined by using complete block design
- The questionnaire was designed using the compusense five
- Sample portions of 30ml were served at 4°C in clear plastic cup with a three-digit random number
- Samples were presented in balance, random order according to the randomised block design
- All samples were prepared on the same day of the test, with the same way, using the same raw materials and under the same conditions.

1	2	3	4	5	6	7	8	9
Dislike extremely	Dislike very much	Dislike medium	Dislike slightly	Not like or dislike	Like slightly	Like medium	Like very much	Like extremely

Table 1. The 9-point hedonic scale

Screening experiment design

Factor	Lower limit	Upper limit
% cow's yogurt	7.2	36.5
% water	13	34
% kiwi	8	15
% sugar	6	15

Table 2. Screening experiment factors' limits

16(2⁴)samples: LLLL, LLLH, LLHL, LLHH, LHLL, LHLH, LHHL, LHHH
HLLL, HLLH, HLHL, HLHH, HLLL, HHLH, HHHL, HHHH

- evaluated for sweetness, milk flavour, kiwi flavour, thickness and overall acceptability
- 32 untrained assessors
- in two sessions (8 samples/session)

Screening result – Sweetness



```
> design.rs1 <- rsm(response ~ FO(sugar, kiwi, water, yoghurt) + TWI(sugar, kiwi, water, yoghurt), data = design.CR)
```

Response: response

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(sugar, kiwi, water, yoghurt)	4	325.05	81.264	26.9080	<2e-16
TWI(sugar, kiwi, water, yoghurt)	6	11.77	1.962	0.6497	0.6904
Lack of fit	5	13.55	2.709	0.8962	0.4833

```
> design.rs1 <- rsm(response ~ FO(sugar, kiwi, water, yoghurt), data = design.CR)
```

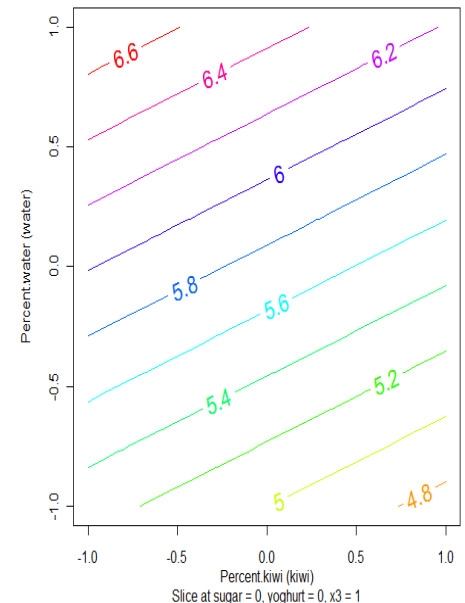
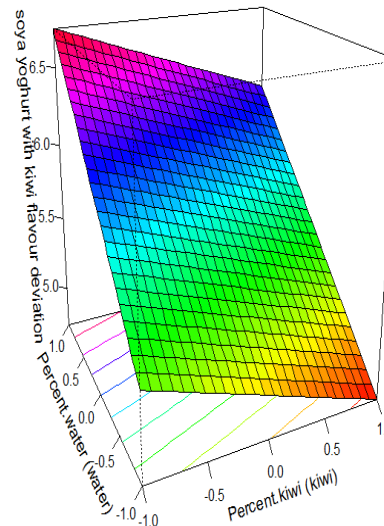
Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
kiwi	-0.27734	0.07664	-3.6190	0.000326 ***
water	0.73047	0.07664	9.531	<2e-16 ***

Response: response

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(sugar, kiwi, water, yoghurt)	4	325.05	81.264	27.0200	<
Residuals	507	1524.82	3.008		
Lack of fit	11	25.32	2.302	0.7614	0.6789

low kiwi percent & high water percent

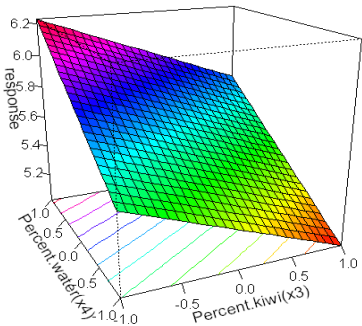
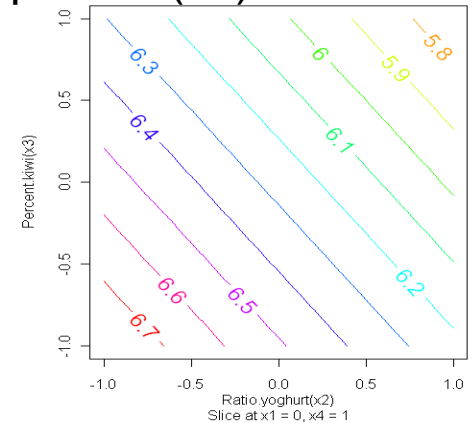
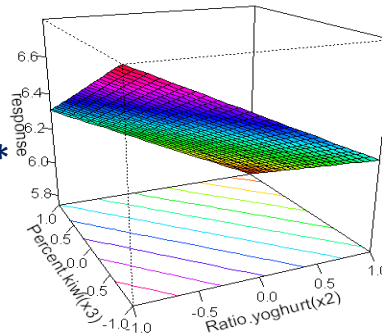


Screening results – Milk flavour

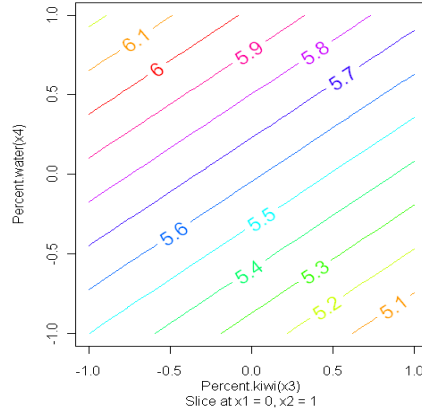
Model FO: cow's yoghurt percent(x2), kiwi percent(x3), water percent(x4)

3 factors have interaction:

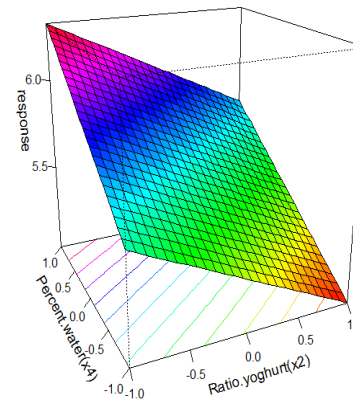
				Pr	
x2	-0.28516	0.07090	-4.022	6.65e-05	***
x3	-0.24609	0.07090	-3.471	0.000563	***
x4	0.36328	0.07090	5.124	4.26e-07	***



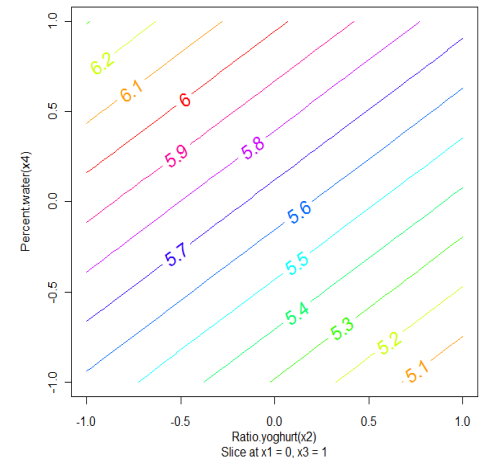
Slice at x1 = 0, x2 = 1



Slice at x1 = 0, x4 = 1



Slice at x1 = 0, x3 = 1



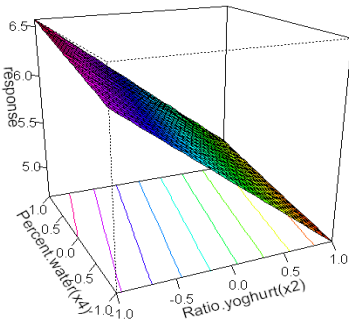
low kiwi percent &
low cow's yoghurt percent &
high water percent

Screening results – Thickness

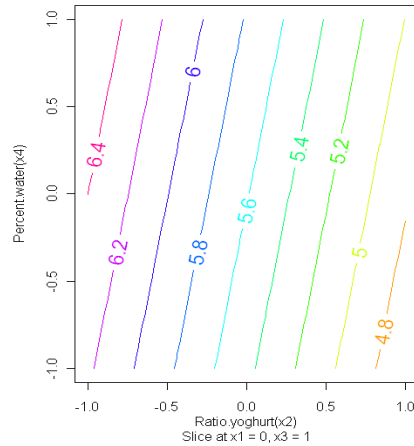
Model FO: cow's yoghurt percent(x2), kiwi percent(x3), water percent(x4)

Estimate Std. Error t value Pr(>|t|)

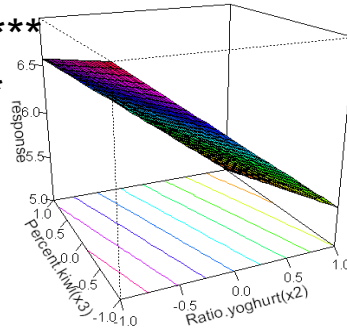
x2	-0.78711	0.08022	-9.812	<2e-16 ***
x3	-0.20508	0.08022	-2.556	0.0109 *
x4	0.16992	0.08022	2.118	0.0346 *



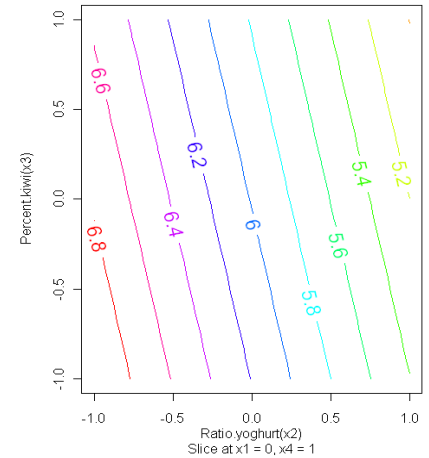
Slice at x1 = 0, x3 = 1



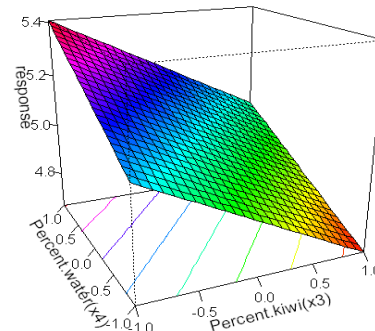
Slice at x1 = 0, x3 = 1



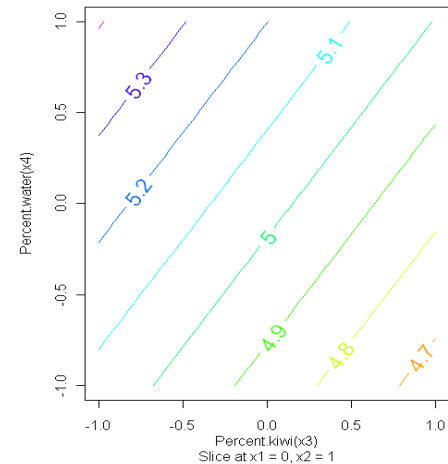
Slice at x1 = 0, x4 = 1



Slice at x1 = 0, x4 = 1



Slice at x1 = 0, x2 = 1



Slice at x1 = 0, x2 = 1

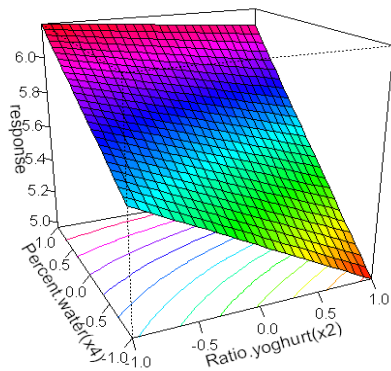
Low percent cow's yoghurt & high percent water

Screening results – Overall

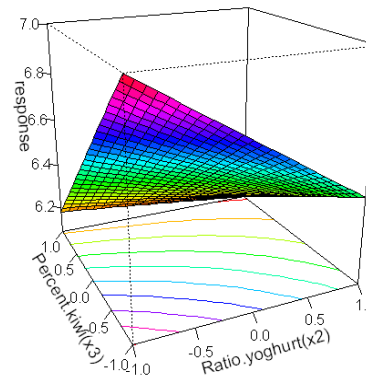
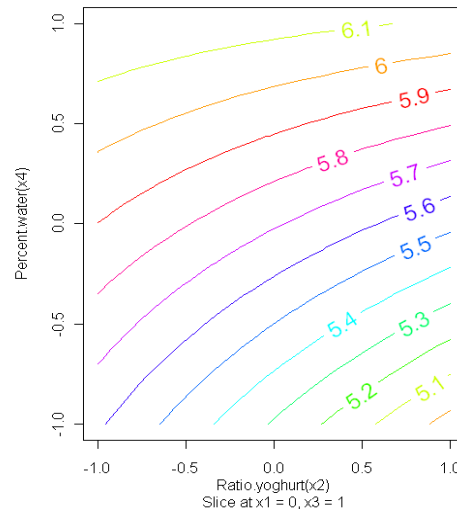
Model FO+TWI: cow's yoghurt percent(x2), kiwi percent(x3), water percent(x4)

Estimate Std. Error t value Pr(>|t|)

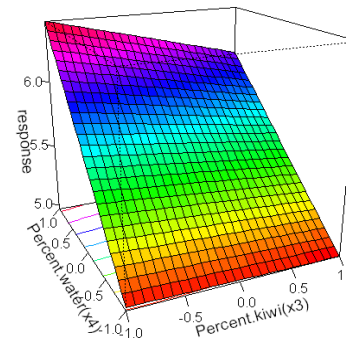
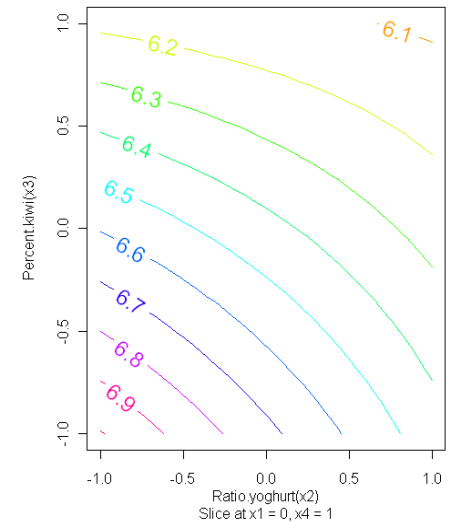
x2	-0.30273	0.07384	-4.100	4.82e-05
x3	-0.21289	0.07384	-2.883	0.0041
x4	0.50586	0.07384	6.851	2.16e-11



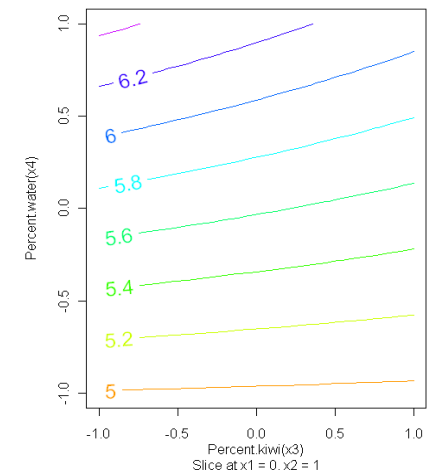
Slice at x1 = 0, x3 = 1



Slice at x1 = 0, x4 = 1

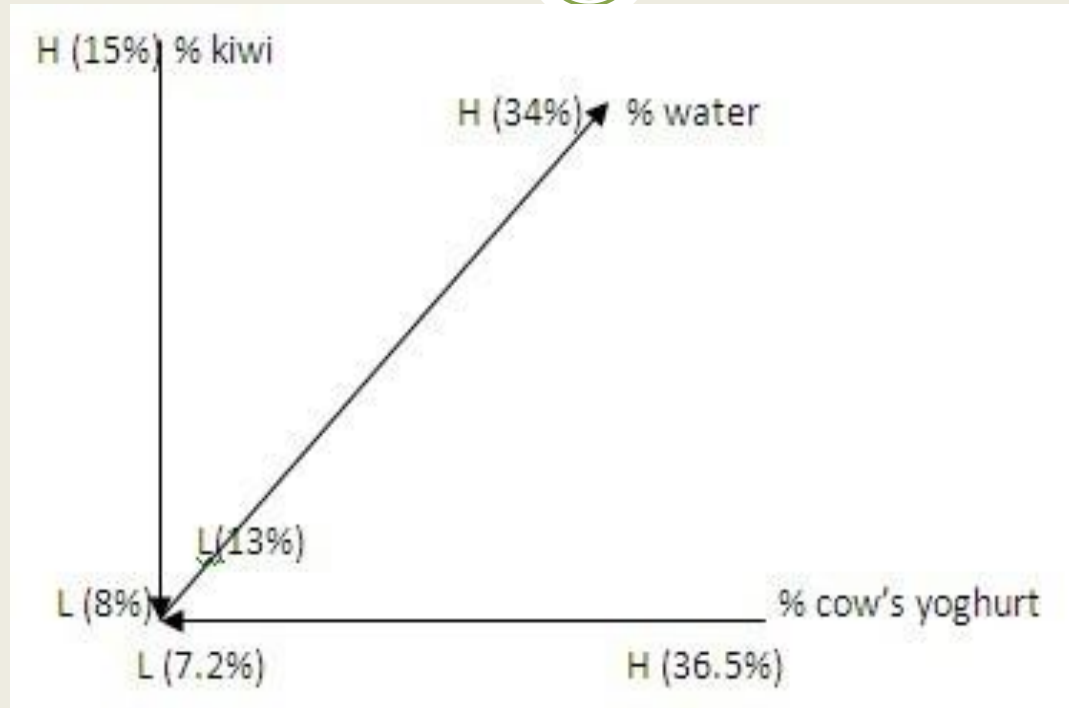


Slice at x1 = 0, x2 = 1



Low percent cow's yoghurt &
low percent kiwi &
high percent water

Screening results analysis



For all attributes ,for overall acceptability assessors prefer:

low kiwi %, low cow's yoghurt % ,high % of water

Assessors response shows that the products with best sweetness are those with middle % of sugar

Product acceptability and preference experiment design

Factor	Lower level (L)	Medium level (M)	High level (H)
% kiwi	8	10	12
% cow's yogurt	7.2	14.7	22.2

Table 3. Optimisation experiment factors' limits

- 9 samples: LL, LM, LH, ML, MM, MH, HL, HM, HH
- examined by 54 untrained assessors
- single session



Optimization results analysis

Optimization results analysis

SO (second order)

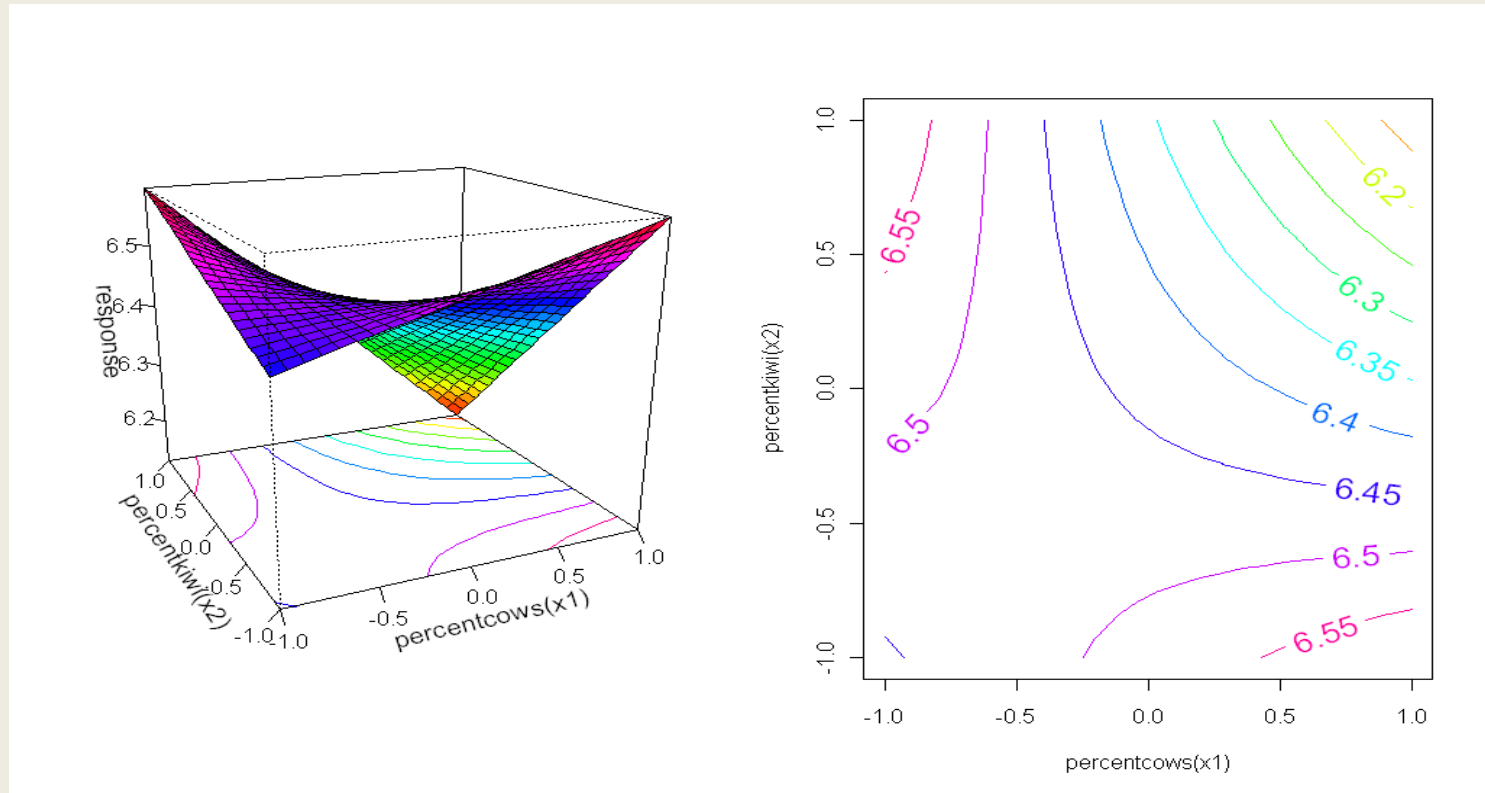


Figure 1. Response surface plot for Kiwi flavor, (X1= % cow's yogurt, X2=% kiwi juice)

Optimization results analysis

SO (second order): optimise region of cow's yoghurt should be around middle level & low percent kiwi

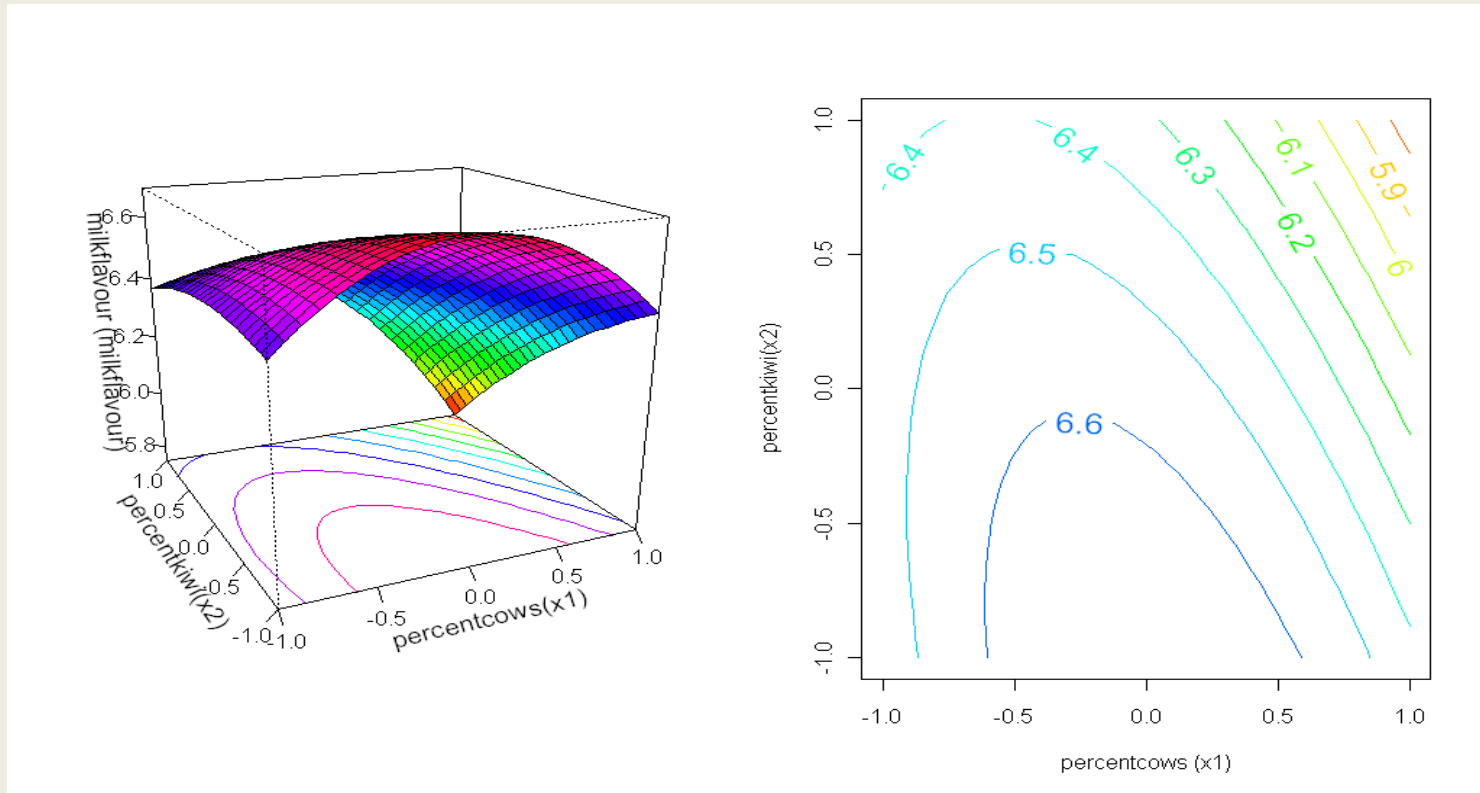


Figure 2. Response surface plot for milk flavor, (X1= % cow's yogurt, X2=% kiwi juice)

Optimization results analysis

FO + TWI: optimise region of kiwi percent and cow's yoghurt percent are at middle level

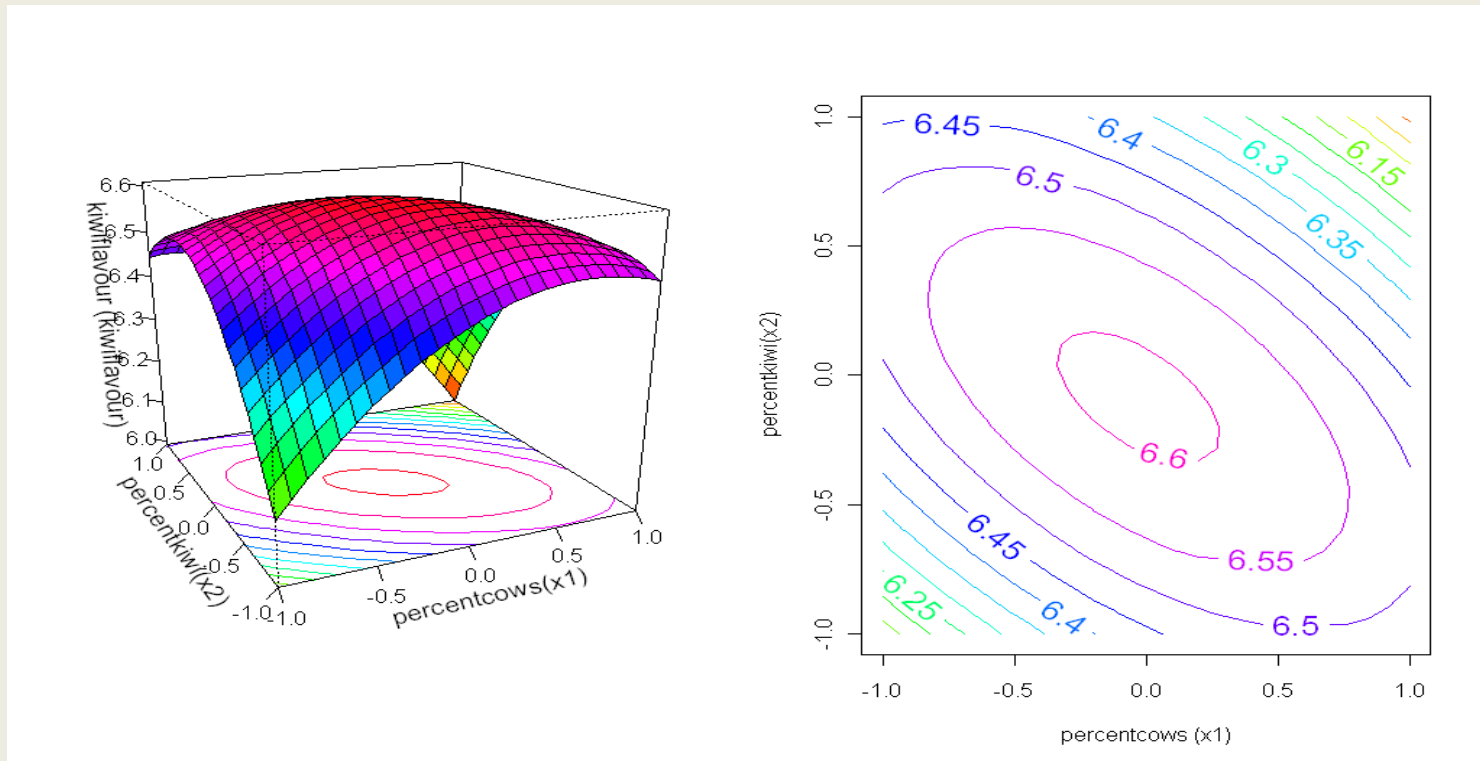


Figure 3. Response surface plot for overall acceptability, (X1= % cow's yogurt, X2=% kiwi juice)

- ✓ Best formulation for percentage of kiwi juice and cow' s yogurt is at 14.5% and 9%



Product formulation and Process specification

Raw material



Raw material (For 1000g drink)	Specification	Quantity
Cows yogurt	“Morrisons” low fat (1.5%)	14.5% (145gm)
Soy yogurt	“Alpro”	47.5% (475 gm)
Water	Sterilized tap water from lab	20% (200gm)
Kiwi	“Morrisons” mature	9% (90gm)
Sugar	“Morrisons” granulated sugar	10% (100gm)

Table 4. Raw material specification for lab scale

Process specification



- Time
- Temperature
- pH
- Pressure
- Hygiene
- Microbiological and chemical parameters

Product specification



- Raw material
- pH
- TSS
- Temperature
- % of fat
- SNF

Packaging



Primary



Secondary



Tertiary



250 ml
PET



Cartons



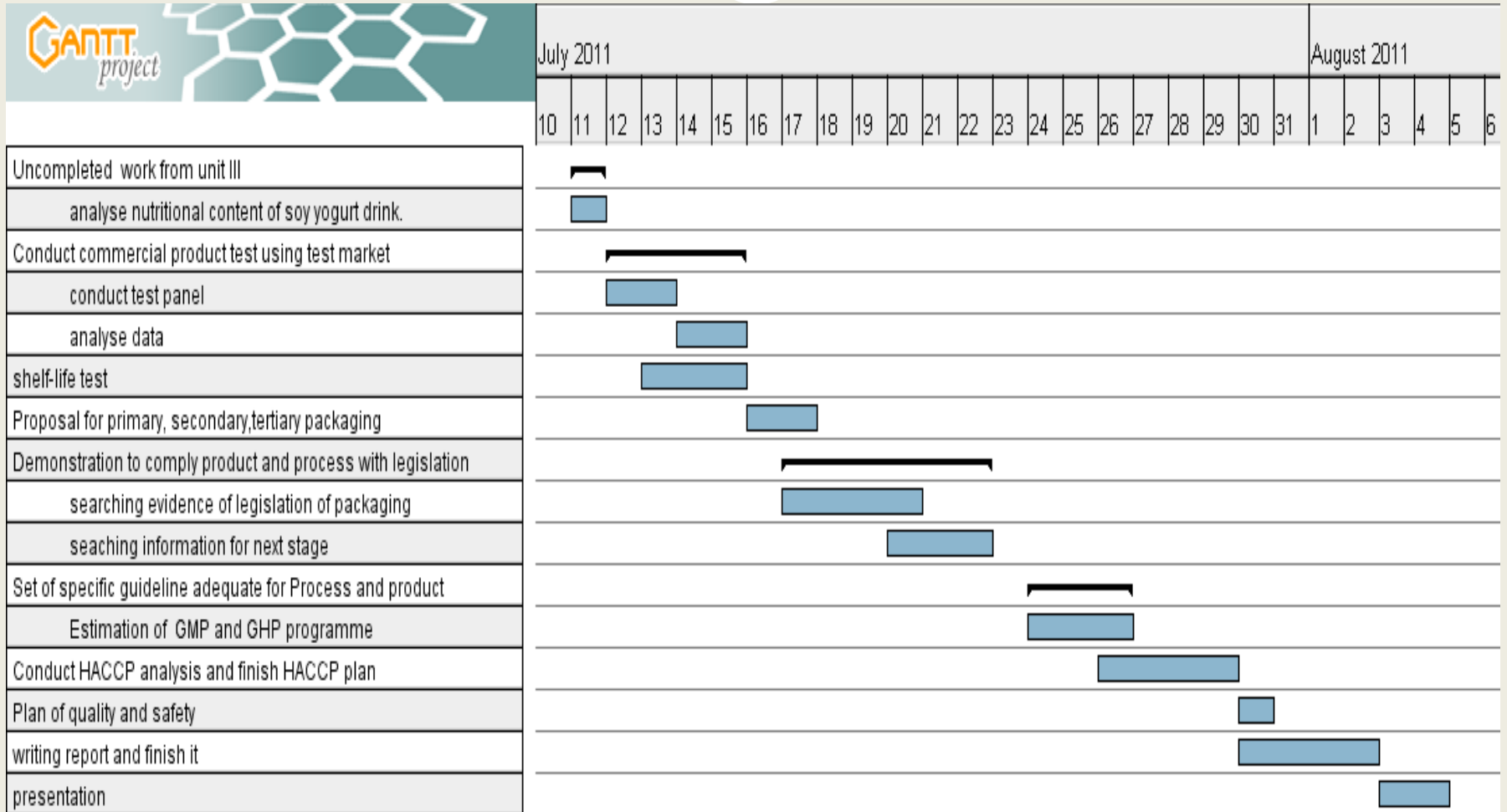
Crates

Conclusion



- Description of process and equipment flowcharts, and check if the production process is in compliance with relevant regulations
- Factory layout design for the production process
- Conduct product acceptability and preference test
- Design experiments for conducting product & process optimisation
- Determine product formulations & the process formulations

Plan of action





Thank you

